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Parasites of Three Species of South Dakota Lagomorphs

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PARASITES OF THREE SPECIES OF SOUTH DAKOTA LAGOMORPHS

by

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PARASITES OF THREE SPECIES

OF SOUTH DAKOTA LAGOMORPHS

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Advisor Date

Head, Biology Department Date

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-- GEKJ

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INTRODUCTION

The wild lagomorphs of North America have in the past been the subject of numerous parasitological examinations. Many of these surveys have been performed on cottontail rabbits (Sylvilagus spp.), while comparatively fewer studies have been done on the jack rabbits (Lepus spp.). In South Dakota, parasite surveys have yet to be completed on both cottontail rabbits and jack rabbits.

The representatives of the Leporidae found in South Dakota are the white-tailed jack rabbit (Lepus townsendii campanius), the black-tailed jack rabbit (Lepus californicus melanotis), the eastern cottontail rabbits (Sylvilagus floridanus similis and Sylvilagus floridanus mearnsii), the desert cottontail rabbit (Sylvilagus audubonii baileyi) and the Black Hills cottontail rabbit (Sylvilagus nuttalli grangeri) (Hall, 1981). The species examined for parasites in this study however, included only Lepus townsendii campanius, Sylvilagus floridanus similis and Sylvilagus audubonii baileyi.

Since the parasites of hares and rabbits have never been studied in South Dakota, this study will present data on the subject. The objectives of this research were as follows:

1) To determine the species of parasites and their incidence in the three lagomorph species studied.

2) To determine the distribution of each parasite species found in South Dakota lagomorphs.

3) To summarize the data concerning parasites of other areas in relation to the parasites found in South Dakota.

METHODS

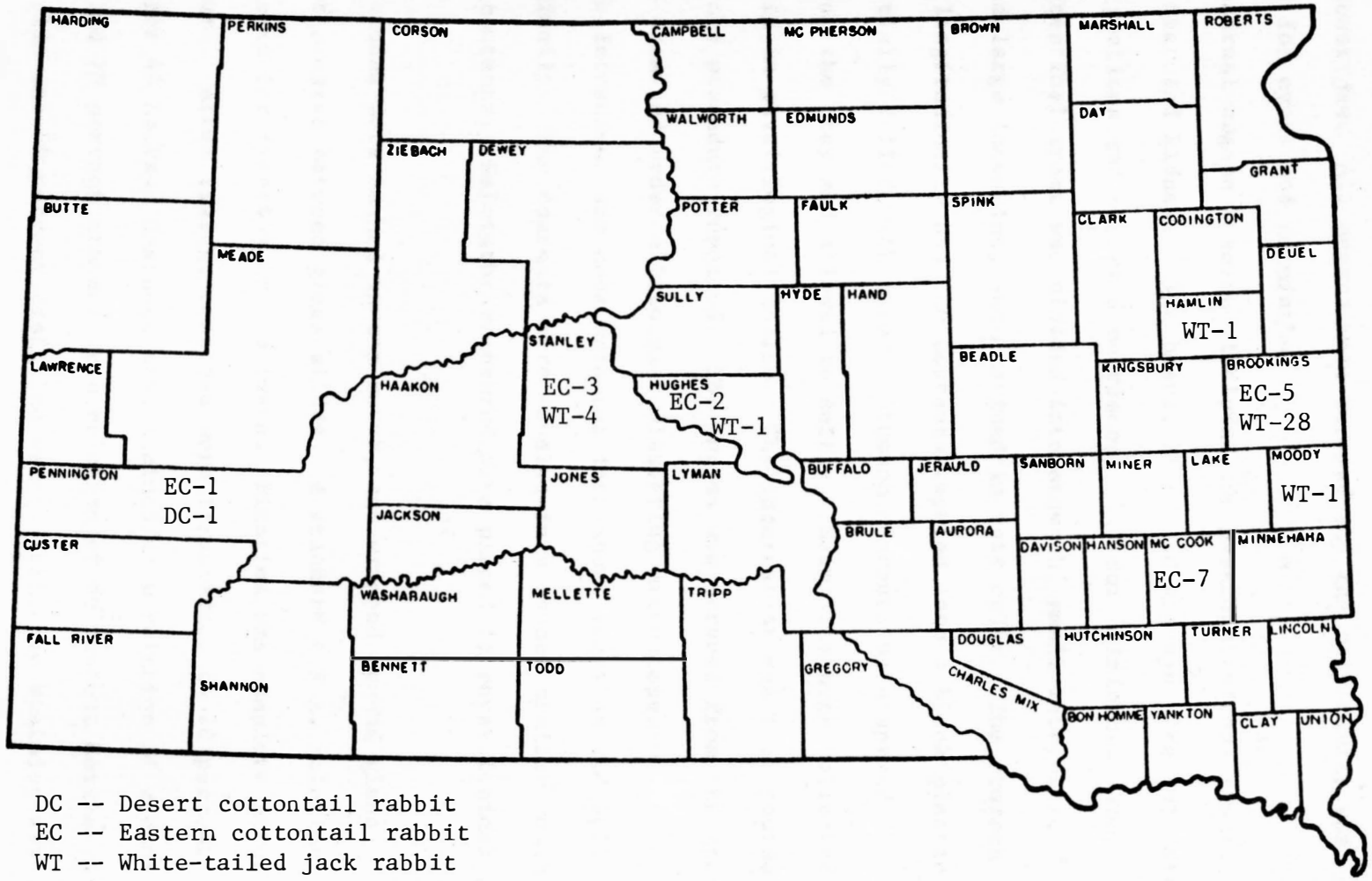
During this study 35 white-tailed jack rabbits, 18 eastern cottontail rabbits and one desert cottontail rabbit were examined for parasites. All lagomorphs were shot with either a 12-guage shotgun or a 22 caliber rifle between October 13, 1982, and June 10, 1983. The distribution of lagomorphs examined in this study is illustrated in Map I.

When killed, the lagomorphs were usually placed in white plastic bags to prevent the escape of ectoparasites. Specimens were necropsied as soon after death as possible or frozen until adequate time was available for their dissection.

Lagomorphs were brought to room temperature, removed from the plastic bags, and placed in a high-sided, enameled pan. Each specimen was combed to remove parasites from the fur, and bags were examined for any additional parasites which may have fallen from the host. In preparation for study, ectoparasites were handled by two methods. Ticks were left in small screw-cap vials filled with 70 percent ethanol. Fleas were cleared in a 10 percent KOH solution. Dehydration was accomplished by placing the fleas in successive solutions of 35 percent, 50 percent, 70 percent, 90 percent and absolute ethanol. Specimens were transferred to pure xylol prior to mounting. Canada balsam was the mountant used.

The lagomorphs were skinned and inspected for subcutaneous nematodes. The body was then opened with an incision from the anus

Map I. Distribution of Wild Lagomorphs Examined During This Study



DC -- Desert cottontail rabbit
EC -- Eastern cottontail rabbit
WT -- White-tailed jack rabbit

Figure indicates the number of lagomorph samples collected in that county.

to the lower jaw. All organs were removed and the body cavity was examined for cysts and helminths.

Internal organs examined included the gastrointestinal tract, heart, liver and kidneys. The heart, liver and kidneys were cut into 1/4-inch sections and observed macroscopically for helminths. The gastrointestinal tract was divided into stomach, small intestine, cecum and large intestine, and examined in this order. The stomach was cut longitudinally and the contents emptied into a black plastic tray partially filled with water. Stomach contents were spread throughout the tray and allowed to settle. Helminths were collected and placed in physiological saline. The supernatant was then poured off and the procedure repeated. The mucosa was scraped from the stomach and examined under a binocular dissecting microscope.

The intestines and ceca were cut into short sections and split longitudinally. The contents were handled in a manner similar to the stomach contents. Helminths recovered were placed in physiological saline.

Cestodes were washed in tap water, and wrapped around glass slides or pressed between glass slides. A standard A.F.A. solution was employed for fixation of specimens. Fixation was complete after 24-48 hours. After fixing, cestodes were transferred to 70 percent ethanol for 48 hours. Cestodes were stained in a solution of aceto-carmine and 70 percent ethanol or a solution of 50 percent Harris haematoxylin and 50 percent distilled water. Prior to staining with haematoxylin, cestodes were placed in a solution of aluminum alum and

distilled water for one hour. Destaining was performed in 70 percent ethanol by adding a few drops of concentrated hydrochloric acid. Dehydration was completed by placing cestodes in successive solutions of 70 percent, 90 percent and absolute ethanol. Clearing took place in solutions of 50 percent xylol - 50 percent absolute ethanol and pure xylol. Canada balsam was the mounting medium used.

Nematodes were washed in tap water, fixed in A.F.A. for 24-48 hours, and transferred to 70 percent ethanol for 48 hours. They were then placed into a glycerine - 70 percent ethanol solution. Specimens were cleared by allowing the ethanol to evaporate. The cleared nematodes were then left in pure glycerine.

Photomicrographs of most specimens were taken with a Nikon Microflex PFM camera and Kodak Plus-X Pan, PX-135 film. The camera was mounted on a Nikon SMZ-10 stereoscopic microscope. Photomicrographs were occasionally taken with a Leitz camera and microscope.

WHITE-TAILED JACK RABBIT

Lepus townsendii campanius

According to Hall (1981) two species of hare are found inhabiting South Dakota, the black-tailed jack rabbit (*Lepus californicus melanotis*) and the white-tailed jack rabbit (*Lepus townsendii campanius*). Literature concerning the parasites of *Lepus californicus* is quite abundant while published literature concerning the parasites of *Lepus townsendii* is rather limited.

Literature Review Concerning Helminths in White-tailed Jack Rabbits

In 1896 Stiles revised the adult cestodes of hares and rabbits. This was followed in 1902 by a study of the genus *Cittotaenia* by Lyman.

Hall (1912) compiled a list of parasites found in Colorado. Cestodes from *Lepus campestris* that were recovered included *Taenia pisiformis* (cysticerci), *Multiceps serialis* (coenuri) and *Davainea salmoni*.

In 1915 Douhitt monographed the cestode family Anoplocephalidae. Hall (1916) reviewed the parasitic nematodes of the orders Rodentia, Lagomorpha and Hydracoidea.

Meggitt (1924) listed the cestodes found in lagomorphs as well as those found in other mammals. Yorke and Maplestone (1926) reported on the known parasitic nematodes of vertebrates.

Coenuri of *Multiceps serialis* were collected from both *Lepus*

californicus and Lepus townsendii in Colorado by McCampbell (1926). From 10 to 90 percent of the hares examined were infected. Tapeworms of the genus Cittotaenia were also recovered from nine of ten black-tailed hares examined.

Schwartz and Shook (1928) reported on the diseases and parasites of rabbits. The pathologic conditions associated with the nematode Dermatoxys veligera were observed and documented by Wetzel (1931).

Alicata (1932) described the life stages of Obeliscoides cuniculi. The life history of this nematode was also disclosed.

Seventeen black-tailed jack rabbits (Lepus californicus) were examined for helminths in central Oklahoma by Ward (1934). Four cestode species and three nematode species were recovered from the hares.

Additional knowledge concerning the anoplocephaline cestodes of North American rabbits was contributed by Arnold (1938). Stunkard (1941) revealed the life histories of the anoplocephaline cestodes of lagomorphs. Free-living mites were discovered as being the intermediate host for tapeworms of the genus Cittotaenia.

Liver flukes (Fasciola hepatica) were recovered from 99 of the 309 jack rabbits examined by Olsen (1948) in Texas. The hares were considered to be reservoir hosts of this trematode.

Hamilton (1950) described the morphology and elaborated on the occurrence of Coenurus serialis from rabbits. In a comprehensive work, the literature concerning the cestodes of the world was brought

up to date by Wardle and McLeod (1952).

Grundmann, et al. (1955) recovered a huge coenurus of Multiceps serialis from the coelomic cavity of a black-tailed jack rabbit in Utah. The cyst possessed several hundred daughter coenuri with thousands of scolices.

Honess and Winter (1956) working in Wyoming, reported on several helminths found in wild lagomorphs. The helminths found in Lepus townsendii included both cestodes and nematodes. Cestodes found were Raillietina (Paroniella) retractilis (Davaineidae) and Mosgovoyia pectinata americana (Anoplocephalidae). No larval cestodes were recovered.

The only nematodes found by Honess and Winter (1956) to infest Lepus townsendii were Protostrongylus sylvilagi and Dermatoxys veligera. Only light infections of Dermatoxys veligera were encountered. The lungworm Protostrongylus sylvilagi, when present in high numbers, causes verminous pneumonia in rabbits.

In California, Lechleitner (1959) reported on the parasites and diseases of black-tailed jack rabbits. Lyons, et al. (1960) examined 130 black-tailed jack rabbits from Kansas for helminths. Ten species, including both cestodes and nematodes, were found.

Honess (1963) reviewed the unarmed cestodes of Wyoming rabbits. Mosgovoyia pectinata americana was the variety reported from Lepus townsendii.

The only paper reviewed that dealt entirely with the parasites of Lepus townsendii was that of Voth and James (1965) working in

North Dakota. The helminths collected from 108 hares and their prevalence were as follows: Cestoda: Cittotaenia sp., 3.2 percent; Multiceps sp., 8.2 percent; Taenia pisiformis (cysticerci), 3.2 percent; Raillietina (Raillietina) loeweni, 15 percent; Nematoda: a filariid sp. (possibly Micipsella brevicauda), 6.9 percent.

Levine (1968) reported on the nematode parasites of man and domestic animals. Thorne, et al. (1982) revised and updated Honess' book on the diseases and parasites of wildlife in Wyoming. The characteristics of natural infections of Obeliscoides cuniculi in woodchucks (Marmota monax) and lagomorphs was studied in Canada by Measures and Anderson (1983b).

Table A in Appendix I lists the helminths from Lepus townsendii in North America.

Helminths Collected in this Study

Thirty-five white-tailed jack rabits (Lepus townsendii campanius) were examined for helminths in this study. Table 1 lists the helminths found and their prevalence.

The most conspicuous helminths recovered from white-tailed jack rabbits were the coenuri of Multiceps serialis. Mature forms of Multiceps serialis are found primarily in dogs or other wild carnivores (McCampbell, 1926).

Coenuri are quite variable in size, depending on the site of encystment. They can range from cherry pit size to larger than an apple and contain several hundred scolices (McCampbell 1926, Schwartz and Shook 1928, Grundmann, et al. 1955).

Table 1. Helminths of Thirty-five White-tailed Jack Rabbits from South Dakota

Species	Organ Infested	No. Infested	Prevalence	Distribution
CESTODES				
Multiceps serialis (coenuri)	internal lumbar and left thigh musculature	2	5.7%	Brookings County, S.D.
Cittotaenia pectinata americana	small intestine	3	8.6%	Brookings County, S.D.
NEMATODES				
unidentified female; possibly *Obeliscoides cuniculi* or *Graphidium strigosum*	stomach	1	2.9%	Brookings County, S.D.

Two coenuri of Multiceps serialis were collected by the author. The first coenurus measured 63.5 mm in diameter and contained 371 scolices showing various states of maturity. The cyst was located just anterior to the right kidney and had displaced the adrenal gland. The second coenurus measured 51.0 mm in diameter and contained hundreds of scolices, again showing various states of maturity. This cyst was removed from the left thigh musculature.

Although coenuri of Multiceps serialis occasionally attain large sizes, they do not appear to alter the health or hamper the activity of affected rabbits (McCampbell 1926, Lechleitner 1959). Large numbers of coenuri also do not appear to impede the normal activities of affected rabbits.

Mature tapeworms were collected from three of the 35 white-tailed jack rabbits examined. The six cestodes recovered were identified as Cittotaenia pectinata americana.

Prior to the work of Honess and Winter (1956), C. p. americana and C. perplexa were easily confused. Honess (1963) offered suggestions on how the two could be distinguished from each other morphologically. In C. p. americana the scolex is rounded, the neck is broadest in the middle and the first proglottids increase very rapidly in width. C. perplexa in comparison has a scolex almost truncate, neck about the same width as the scolex and the first proglottids increase less rapidly in width (Honess 1963). These characteristics were used by the author in making identifications.

Schwartz and Shook (1928) reported that lagomorphs harboring

one or a few mature cestodes are not greatly affected by their presence. In severe infestations however, death may occur from emaciation and severe anemia.

A single nematode was removed from the stomach of a white-tailed jack rabbit. The female nematode could not be definitely identified due to lack of a male specimen of the same species.

Female Obeliscoides cuniculi resemble the females of Graphidium strigosum, and both are found in the stomach of North American lagomorphs (Yorke and Maplestone 1926, Alicata 1932, Levine 1968). According to Yorke and Maplestone (1926), female G. strigosum are characterized by a small head, relatively large mouth, cuticle with numerous longitudinal striae, cervical papillae present, vulva in the posterior third of the body (which narrows abruptly behind it), and length of 11-20 mm. Characteristics of female O. cuniculi, also from Yorke and Maplestone (1926), are as follows: mouth simple, buccal capsule absent, cervical papillae present, vulva in posterior fourth of body, and worms measuring from 11-18.5 mm in length.

Small numbers of stomach worms appear to have little effect on infested lagomorphs, while heavy worm burdens may cause emaciation, diarrhea or death (Schwartz and Shook 1928, Erickson 1944). These authors also reported that the pathological condition associated with stomach worm infestations is the formation of ulcers when worms burrow into the mucosa of the stomach wall.

Arthropods Collected in this Study

Since this study was primarily concerned with the helminths of lagomorphs, a comprehensive literature search on ectoparasites was not undertaken. A few representative works, however, were consulted.

All 35 white-tailed jack rabbits (Lepus townsendii) collected were examined for ectoparasites. The parasites found are illustrated in Table 2. Prevalences of ectoparasites could not be figured since a majorty of the lagomorphs collected were not handled individually.

Cediopsylla simplex (Pulicidae) has been reported as a common parasite of hares and rabbits in the eastern United States (Kohls 1940, Ewing and Fox 1943, Jellison and Senger 1973, Andrews et al. 1980b, Stohlein and Christensen 1983). Cediopsylla simplex was the most common flea collected from the white-tailed jack rabbit in eastern South Dakota. Twenty-eight specimens of Cediopsylla simplex, including 10 males and 18 females, were collected by the author.

Euhopsyllus glacialis affinis (Pulicidae) is a common parasite of wild lagomorphs in the western United States, but occasionally it is found in eastern states in low numbers (Kohls 1940, Jellison and Senger 1973, and Andrews et al. 1980). One female and three male specimens of Euhoplopsyllus glacialis affinis were recovered by the author from hares of Brookings County, South Dakota.

Pulex irritans was the final member of the Pulicidae to be recovered from white-tailed jack rabbits by the author. One male specimen was taken from a Brookings County hare. This flea has been reported from a variety of hosts and locations throughout the United

Table 2. Ectoparasites from Thirty-five White-tailed Jack Rabbits from South Dakota

Species	Parasite Location	Sex		Distribution
		Male	Female	
SIPHONAPTERA				
Opisocrostis bruneri	fur	0	2	Brookings County, S.D.
Pulex irritans	fur	1	0	Brookings County, S.D.
Euhoplopsyllus glacialis affinis	fur	3	1	Brookings County,
Cediopsylla simplex	fur	10	18	Brookings, Hamlin and Moody Counties, S.D.

*Determinations made by Dr. Omer Larson, Department of Biology, University of North Dakota, Grand Forks, N.D. 58202.

States, so its collection here does not seem to be unusual (Kohls 1940, Jellison and Senger 1973).

Two female specimens of Opisocrostis bruneri (Ceratophyllidae) were taken from two Brookings County hares. This appears to represent an accidental relationship since Opisocrostis bruneri is primarily a parasite of North American ground squirrels, genus Spermophilus (Jellison and Senger 1973, McKenna et al. 1977).

Four species of ectoparasites were found infesting white-tailed jack rabbits in South Dakota. The parasites do not, however, represent any new state records according to Easton (1982).

EASTERN COTTONTAIL RABBIT

Sylvilagus floridanus similis

Sylvilagus floridanus mearnsii and *Sylvilagus floridanus similis* are the two subspecies of eastern cottontail rabbit found in South Dakota (Hall 1981). *S. f. mearnsii* inhabits the extreme southeastern corner of the state while *S. f. similis* is prevalent over the remainder of the state excluding the Black Hills (Hall 1981).

From a parasitological point of view, the eastern cottontail rabbit (*Sylvilagus floridanus*) is one of the most thoroughly studied of all lagomorphs. Studies have been performed in a majority of the eastern states.

Literature Review Concerning Helminths in Eastern Cottontail Rabbits

The adult tapeworms of hares and rabbits were revised by Stiles (1896). Both North American and European forms were studied.

Seventy cottontail rabbits were examined by Lyman (1902) for cestodes. *Cittotaenia variabilis* and *Cittotaenia variabilis angusta* were recovered from some of these rabbits.

The cestode family Anoplocephalidae was monographed by Douhitt (1915). It was at this time that the name *Cittotaenia pectinata americana* was proposed to avoid confusion with the European form *Cittotaenia pectinata*.

Hall (1916) classified the nematode parasites of mammals in the orders Rodentia, Lagomorpha and Hydracoidea. He described 15 species

from the rabbit. Five cestode species were reported from Sylvilagus floridanus by Meggitt (1924). Graybill (1923) described a new species of trichostrongylid nematode from two wild rabbits from New Jersey. The designated name was Trichostrongylus affinis. Other nematodes from these two rabbits were also recovered.

Jewell (1925) reported on a heavy infestation of Taenia pisiformis (cysticerci) in a Mearns cottontail (Sylvilagus floridanus mearnsii) from Kansas. Excluding parasites in the lungs and liver, 1015 cysticerci were removed from the rabbit.

All of the known nematodes occurring in vertebrates were classified by Yorke and Maplestone (1926). Schwartz and Shook (1928) compiled a list of helminths occurring in rabbits. A more complete list of rabbit helminths was given by the Imperial Bureau of Agricultural Parasitology (1931).

While performing a study of the nematodes found in captive animals at the New York Zoological Park, McClure (1932) examined a cottontail rabbit that was wild in the park. Passalurus nonanulatus and Dermatoxys veligera were the nematodes found.

The life history of Obeliscoides cuniculi, the rabbit stomach worm, was revealed by Alicata in 1932. Descriptions of the life stages were also included.

LeDune (1933) surveyed 126 rabbits (Sylvilagus floridanus) from 40 Ohio counties. The nematodes found, from highest to lowest prevalence, included Obeliscoides cuniculi, Trichostrongylus retortaeformis, Trichuris leporis, Dermatoxys veligera, Nematodirus leporis and

Heterakis gallinae. The latter species was found in only one rabbit and was considered to be an accidental parasite. Cestodes were also found.

In a study of the parasites of rabbits in central Oklahoma, Ward (1934) examined 52 cottontail rabbits. Six species of helminth were reported including Taenia pisiformis (cysticerci), Cittotaenia ctenoides, Hepaticola hepatica, Passalurus ambigous, Obeliscoides cuniculi and Graphidium strigosum.

Honess (1935) conducted studies on the cestodes of the Black Hills cottontail rabbit (Sylvilagus nuttalli grangeri) in Wyoming. Four species were reported on. Honess (1935) also gave life history information on Cittotaenia variabilis.

Dikmans (1937) described Trichostrongylus ransomi from a Louisiana cottontail rabbit. Further work on the anoplocephaline cestodes of North American rabbits was completed by Arnold (1938). Cestodes of the genera Cittotaenia, Schizotaenia and Andrya were illustrated and described.

Clancy et al. (1940) examined 342 Connecticut cottontails for internal parasites. The four species found were Obeliscoides cuniculi, Passalurus ambiguus, Cittotaenia variabilis and Cysticercus pisiformis.

Two hundred and ten Iowa cottontail rabbits (Sylvilagus floridanus mearnsii) were examined for parasites by Morgan and Waller (1940). Seven helminth species, including the trematode Hasstilesia tricolor, were collected. One rabbit was reported to have over 10,000 flukes in the small intestine.

The life histories of the anoplocephaline cestodes of hares and rabbits were studied by Stunkard (1941). It was found that oribatid mites serve as the intermediate hosts for cestodes of the genus Cittotaenia.

Smith (1941) completed a study on the food and parasites of 11 swamp rabbits (Sylvilagus aquaticus aquaticus) and 31 cottontail rabbits (Sylvilagus floridanus alcer) in an Oklahoma lowland. Seven species of helminths were recovered from each of the two rabbit species, but the prevalence of the parasites varied markedly between them.

Rozycki (1941) examined 140 cottontail rabbits (Sylvilagus floridanus) for nematodes. Rabbits were secured from 10 states, and the heminths recovered represented 10 species.

The life history of the cottontail rabbits found in southwestern Michigan was studied by Haugen (1942). Twenty-one rabbits were examined for helminths with four species being recovered.

Bell and Chalgren (1943) examined 27 cottontail rabbits for endoparasites. Hasstilesia tricolor, Cittotaenia perplexa and Cittotaenia variabilis were the trematodes and cestodes recovered respectively. Nematodes found in this study were combined with the data of Rozycki (1941).

The common rabbit of Massachusetts (Sylvilagus floridanus transitionalis) was found by Rankin (1946) to harbor both cestodes and nematodes. The helminths recovered from two rabbits included Cittotaenia variabilis, Taenia pisiformis (cysticerci), Obeliscoides cuniculi and Passalurus ambiguus.

Erickson (1947) reported on the helminths of 97 southern Minnesota cottontail rabbits (Sylvilagus floridanus mearnsii). Sixteen species of helminth were recovered from these rabbits. Erickson (1947) also reviewed the literature and provided keys to the Trematoda, Cestoda and Nematoda in rabbits of the genus Sylvilagus.

Fifty Alabama cottontail rabbits (Sylvilagus floridanus mallurus) were examined for internal parasites by Moore and Moore (1947). Obeliscoides cuniculi had the highest prevalence of the 11 species of helminths collected.

Olsen (1948) showed that wild cottontail rabbits in southern Texas served as reservoir hosts for liver flukes (Fasciola hepatica). The morphology and occurrence of Coenurus serialis was observed by Hamilton (1950). Tiner (1950) described Trichuris sylvilagi from a Maryland cottontail rabbit (Sylvilagus floridanus mallurus).

The available literature concerning tapeworms of the world was brought up to date by Wardle and McLeod (1952).

Filarial worms, Dirofilaria scapiceps, were recovered from a single Connecticut cottontail rabbit (Sylvilagus floridanus mallurus) by Penner et. al. (1953). Three other rabbits from the same area possessed microfilariae of Dirofilaria scapiceps in the blood.

Twenty-five Illinois cottontail rabbits (Sylvilagus floridanus mearnsii) were examined for helminths by Ecke and Yeatter (1956). Four species of helminth were collected from these rabbits.

The helminths found to be associated with cottontail rabbits in Wyoming are Ctenotaenia variabilis, Mosgovoyia pectinata americana and

Mosgovoyia perplexa of the Anoplocephalidae and Raillietina (Fuhrmannetta) stilestella of the Davaineidae (Honess and Winter 1956). No larval cestodes or nematodes were reported from the eastern cottontail in Wyoming.

Dirofilaria scapiceps was reported from two Ohio cottontails (Sylvilagus floridanus mearnsii) by Crites and Phinney (1958). Seventy-six of these nematodes were removed from one rabbit and 84 were removed from the other.

A single Alabama cottontail was necropsied by Price and Ingram (1959). A total of nine helminth species were recovered from this rabbit.

Honess (1963) reported on the anoplocephaline cestodes of Wyoming hares and rabbits. Descriptions of Ctenotaenia variabilis, Mosgovoyia pectinata americana and Mosgovoyia perplexa were included

Cottontail rabbits from Mississippi were collected and examined for helminths by Heard (1963). The three species found were Cittotaenia ctenoides, Cysticercus pisiformis and Dirofilaria scapiceps.

Eight species of helminths were collected from 138 Kansas cottontails (Sylvilagus floridanus) that were examined by Franklin et al. (1966). Obeliscoides cuniculi was the most prevalent species recovered.

Ten Virginia cottontail rabbits (Sylvilagus transitionalis) were necropsied by Holloway (1966). A total of six helminth species were collected.

The cottontail rabbits of North Carolina were surveyed for parasites by Stringer et al. (1969). The helminths recovered represented 11 species, these being taken from 111 rabbits.

The gastro-intestinal tracts of 31 North Dakota cottontail rabbits were examined by Novlesky and Dyer (1970). The cestode Ctenotaenia variabilis was the most prevalent of the eight helminth species recovered.

Nine species of helminths were recovered from two populations of cottontail rabbits in Virginia (Jacobson et al. 1978). The helminths reported on included a single trematode, two cestodes and six nematodes.

A parasite survey of 186 Pennsylvania cottontail rabbits (Sylvilagus floridanus) was performed by Wiggins, Cosgrove and Rothenbacher (1980). Although primarily concerned with helminth ova and coccidia infections, five helminths including Cittotaenia sp., Hasstilesia tricolor, Obeliscoides cuniculi, Passalurus ambiguus and Trichostrongylus calcaratus were recovered.

The only regional survey of the helminths infesting cottontail rabbits (Sylvilagus floridanus) was undertaken by Andrews et al. (1980a). Eight southeastern states were sampled with 260 rabbits being examined. Fourteen species of helminths were collected which included a single trematode, three cestodes and 10 nematodes.

In Kentucky, Strohlein and Christensen (1983) examined 45 eastern cottontail rabbits for parasites. This study was similar to other surveys in that 9 species of helminths were recovered.

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Measures and Anderson (1983a) reported on the experimental development of Obeliscoides cuniculi cuniculi and Obeliscoides cuniculi multistriatus in laboratory animals. Natural infections of Obeliscoides cuniculi were studied in lagomorphs and woodchucks (Marmota monax) from Ontario, Canada (Measures and Anderson, 1983b). The prevalence of Obeliscoides cuniculi in Ontario cottontails ranged in some areas up to 20 percent.

Table B in Appendix I lists the helminths from Sylvilagus floridanus in North America.

Helminths Collected in this Study

Eighteen eastern cottontail rabbits (Sylvilagus floridanus similis) were examined for helminths. The helminths along with their prevalence are illustrated in Table 3.

The helminths recovered most frequently from eastern cottontails were cestodes of the genus Cittotaenia. Cittotaenia variabilis was present in 77.8 percent of the cottontails in the small intestine. The longest specimens were 254 mm and 305 mm in length, with each possessing more than 580 proglottids. Mature specimens were noticeably absent in rabbits taken in January of 1983. The small cestodes recovered however, resembled Cittotaenia variabilis angusta which was described by Stiles (1896). Fifty-nine of these small cestodes were recovered from one rabbit, and 28 were recovered from another. These small worms were also collected in February and April, but not in large numbers. By mid-April, only mature cestodes were being collected.

Table 3. Helminths of Eighteen Eastern Cottontail Rabbits from South Dakota

Species	Organ Infested	No. Infested	Prevalence	Distribution
CESTODES				
Cittotaenia variabilis	small intestine	14	77.8%	Brookings, Hughes, McCook, Pennington and Stanley Counties, S.D.
Cittotaenia perplexa	small intestine	7	38.9%	Brookings, Hughes, McCook and Stanley Counties, S.D.
Cittotaenia pectinata americana	small intestine	3	16.7%	Brookings and Hughes Counties, S.D.
Taenia pisiformis (cysticerci)	mesentaries of the rectum and liver	6	33.3%	Brookings, Hughes, and McCook Counties, S.D.
NEMATODES				
Dermatoxys veligera	cecum and large intestine	4	22.2%	Brookings, Pennington and Stanley Counties, S.D.

Table 3 (continued)

Species	Organ Infested	No. Infested	Prevalence	Distribution
unidentified females; possibly *Obeliscoides cuniculi* or *Graphidium strigosum*	stomach	2	11.1%	McCook County, S.D.

Cittotaenia perplexa was found in 38.9 percent of the eastern cottontail rabbits examined. Only immature worms were recovered from rabbits in January of 1983. Mature worms became more pronounced by early February. Morphological characteristics used for identification of Cittotaenia perplexa were the truncate scolex, neck about the same width as the scolex and proglottids increasing less rapidly in width. Cittotaenia pectinata americana in comparison has a rounded scolex, the neck broadest in the middle and the proglottids increasing very rapidly in width (Honess 1963).

Cittotaenia pectinata americana was collected from cottontail rabbits in November and January. Cestodes were found in 16.7 percent of the cottontails examined.

The cestodes of the genus Cittotaenia were usually found in low numbers, and did not appear to adversely affect the host. There were no signs of pathogenicity that could be attributed to the presence of these tapeworms.

The cysticerci of Taenia pisiformis were recovered from 33.3 percent of the eastern cottontail rabbits examined. The most common site of attachment was the mesentaries surrounding the rectum, although cysticerci were also found attached to the liver. Taenia pisiformis is parasitic in dogs and other carnivores when mature (Schwartz and Shook, 1928).

The nematode Dermatoxys veligera was collected from the cecum of four cottontail rabbits. The highest infestation was found in a rabbit from Brookings County. In this instance 70 worms were removed

from the cecum. According to Wetzel (1931), the pathogenic stage of Dermatoxys veligera is the fourth stage larva, which attaches to the mucosa of the cecum wall. Adults are usually found free in the lumen of the cecum and large intestine.

Two female nematodes were collected from the stomachs of two cottontails. The nematodes could not be identified, however, due to the absence of a male. The worms could possibly be Obeliscoides cuniculi or Graphidium strigosum since the females of these two worms are morphologically similar, and both occur in the stomachs of North American lagomorphs (Yorke and Maplestone 1926, Alicata 1932, Levine 1968).

Arthropods Collected in this Study

All 18 eastern cottontail rabbits (Sylvilagus floridanus) were examined for ectoparasites. Prevalences were not calculated since the rabbits were rarely treated individually. Table 4 illustrates the parasites found.

Cediopsylla simplex and Euhoplopsyllus glacialis affinis were the two flea species collected from eastern cottontail rabbits in South Dakota. All specimens were recovered in January or April of 1983.

Cediopsylla simplex (Pulicidae) was recovered from cottontails taken in Brookings and McCook counties. One hundred and twenty-four specimens of this common flea were found, including 58 males and 66 females. Kohls (1940), Ewing and Fox (1943) and Jellison and Senger (1973) have reported Cediopsylla simplex as a common parasite of hares

Table 4. Ectoparasites from Eighteen Eastern Cottontail Rabbits from South Dakota

Species	Parasite Location	Sex		Distribution
		Male	Female	
SIPHONAPTERA*				
Cediopsylla simplex	fur	58	66	Brookings and McCook Counties, S.D.
Euhoplopsyllus glacialis affinis	fur	43	70	Brookings and McCook Counties, S.D.
ACARINA				
Haemaphysalis leporispalustris	fur	0	1	McCook County, S.D.

*Flea determinations made by Dr. Omer Larson, Department of Biology, University of North Dakota, Grand Forks, N.D. 58202.

and rabbits in the eastern United States, and so its collection here in high numbers is in agreement. Cediopsylla simplex was first reported from Sylvilagus floridanus in South Dakota by Kohls (1940); the location of collection was Brookings county.

Euhoplopsyllus glacialis affinis (Pulicidae) was also collected from cottontail rabbits in Brookings and McCook counties. One hundred and thirteen specimens were recovered, including 43 males and 70 females. Euhoplopsyllus glacialis affinishas been reported as a common flea of lagomorphs in the western United States (Kohls 1940, Ewing and Fox 1943, Jellison and Senger 1973), but it is occasionally found in eastern states in low numbers as well (Andrews, et al. 1980). Euhoplopsyllus glacialis affinis was first reported from South Dakota rabbits by Kohls (1940).

The only tick collected by the author was Haemaphysalis leporispalustris (Ixodidae). One specimen was recovered in April from a rabbit taken in McCook county. This tick has been reported to be most active in warm months and almost inactive in the winter months in northern states (Eddy 1942, Joyce and Eddy 1942, Harman and Chapman 1977). Since cottontails were collected between November and April, this helps explain why so few specimens were found in this study.

DESERT COTTONTAIL RABBIT

Sylvilagus audubonii baileyi

The desert cottontail rabbit (*Sylvilagus audubonii baileyi*) inhabits the western region of South Dakota according to Hall (1981). This cottontail rabbit is frequently found within black-tailed prairie dog (*Cynomys ludovicianus*) towns since it utilizes the abandoned burrows (Buscher and Tyler 1975).

Literature Review Concerning Helminths in Desert Cottontail Rabbits

The nematode parasites of mammals in the orders Rodentia, Lagomorpha and Hydracoidea were classified by Hall (1916). Fifteen species were described from the rabbit. *Taenia pisiformis* was reported from *Sylvilagus audubonii* by Meggitt (1924).

Honess (1935) studied the tapeworms of the Black Hills cottontail rabbit (*Sylvilagus nuttalli grangeri*). Honess also included life history information on *Cittotaenia variabilis*. Arnold (1938) contributed additional information on the anoplocephaline cestodes of North American rabbits. Free-living mites were discovered by Stunkard (1941) to be the intermediate host of tapeworms in the genus *Cittotaenia*.

In a survey conducted by Herman and Jankiewicz (1943), 44 California cottontail rabbits (*Sylvilagus audubonii*) were examined for parasites. Helminths collected included four species of nematodes and three species of cestodes.

Both nematodes and cestodes were reported from desert cotton-

tails (Sylvilagus audubonii) by Honess and Winter (1956). The species discussed included Capillaria hepatica and Dermatoxys veligera from the Nematoda and Raillietina (Paroniella) retractilis, Raillietina (Fuhrmannetta) stilesiella and cysticerci of Taenia pisiformis from the Cestoda.

It was revealed by Thomas and Honess (1962) that five species of intestinal nematodes infect Wyoming cottontail rabbits. The anoplocephaline cestodes of Wyoming hares and rabbits were described by Honess (1963).

Buscher and Tyler (1975) surveyed four Oklahoma desert cottontail rabbits for helminths. The parasites found included Raillietina (Raillietina) loeweni and Raillietina (Raillietina) sp.

Texas desert cottontails were surveyed by Rodenberg and Pence (1978). The cestode Raillietina loeweni was found in 100 percent of the rabbits examined. Three species of nematodes were recovered, namely, Trichostrongylus calcaratus, Dermatoxys veligera and Passalurus ambiguus.

The helminths from Sylvilagus audubonii in North America are illustrated in Table C, Appendix I.

Helminths Collected in this Study

A single desert cottontail rabbit (Sylvilagus audubonii baileyi) was examined for helminths by the author. The helminths along with their prevalence are listed in Table 5. It should be remembered that since only one desert cottontail was collected, the data concerning helminth prevalences are misleading. Larger numbers of rabbits should

Table 5. Helminths of One Desert Cottontail Rabbit from South Dakota

Species	Organ Infested	No. Infested	Prevalence	Distribution
CESTODES				
Taenia pisiformis (cysticerci)	mesentaries of rectum	1	100%	Pennington County, S.D.
NEMATODES				
Dermatoxys veligera	cecum	1	100%	Pennington County, S.D.

be examined to establish more realistic data concerning the parasites of desert cottontails in South Dakota.

The only cestodes collected by the author from Sylvilagus audubonii were the cysticerci of Taenia pisiformis. Seven specimens were removed from the mesentaries surrounding the rectum.

Dermatoxys veligera was the single nematode species recovered from the desert cottontail. Thirteen specimens were found in the lumen of the cecum. Wetzel (1931) indicated that the fourth stage larva is the pathogenic stage due to the fact that they attach to the mucosa of the cecum wall. Adults are usually found in the lumen.

SUMMARY AND CONCLUSIONS

The 35 white-tailed jack rabbits (Lepus townsendii campanius) examined in this study from South Dakota harbored both helminth and arthropod parasites. Helminths infesting these hares included Multiceps serialis (coenuri), Cittotaenia pectinata americana and an unidentifiable female stomach worm which resembled Obeliscoides cuniculi and Graphidium strigosum. This represents the first report of helminths in white-tailed jack rabbits from South Dakota.

Cediopsylla simplex, Euhoplopsyllus glacialis affinis, Pulex irritans and Opisocrostis bruneri were the arthropod parasites associated with white-tailed jack rabbits in this study. Cediopsylla simplex and Euhoplopsyllus glacialis affinis were the most common fleas recovered. A single human flea, Pulex irritans, was collected from one hare, but the relationship did not appear to be unusual. This flea has been found on a variety of hosts in several locations throughout the United States. Two female specimens of Opisocrostis bruneri were recovered from two Brookings county hares. This represents an accidental relationship since Opisocrostis bruneri is principally a parasite of North American ground squirrels in the genus Spermophilus.

Since a majority of the white-tailed jack rabbits examined in this study were taken in the eastern half of the state (see map I), a study should be undertaken to survey the western hares as well. Such a study would establish a much clearer picture as to the parasites of this large hare in South Dakota.

Eighteen eastern cottontail rabbits (Sylvilagus floridanus similis) from South Dakota were examined in this study. Cittotaenia variabilis was found in 77.8 percent, Cittotaenia perplexa in 38.9 percent and cysticerci of Taenia pisiformis was found in 33.3 percent. Other helminths found in smaller numbers in eastern cottontail rabbits included Cittotaenia pectinata americana, Dermatoxys veligera and two unidentifiable female stomach worms. The stomach worms resembled Obeliscoides cuniculi and Graphidium strigosum which are morphologically similar. This appeared to represent the first report of helminths in eastern cottontail rabbits in South Dakota.

The arthropod parasites associated with eastern cottontails in this study were Cediopsylla simplex, Euhoplopsyllus glacialis affinis and Haemaphysalis leporispalustris. The fleas were found in high numbers, while only one rabbit tick (Haemaphysalis leporispalustris) was recovered.

The single desert cottontail rabbit (Sylvilagus audubonii baileyi) examined during this study from Pennington County, South Dakota, was infested with Dermatoxys veligera and cysticerci of Taenia pisiformis. This constitutes the first report of helminths from the desert cottontail in South Dakota. No ectoparasites were collected from this rabbit.

Since only one desert cottontail rabbit was examined, the data collected may be misleading (see Table 5). Further study of the parasites of desert cottontails should reveal a larger number of parasite species being present and it should also put data concerning parasite

intensities into proper perspective.

The helminths showing a state-wide distriution included Cittotaenia variabilis, Cittotaenia perplexa, Taenia pisiformis and Dermatoxys veligera. Cittotaenia pectinata americana may eventually be proven to have a state-wide distribution as well, but in this study it was found only in Brookings and Hughes counties of South Dakota. Additional collections need to be made before the distributions of Multiceps serialis and the unidentified stomach worms can be defined. Further collections are warranted in any case for the purpose of stomach worm identification.

Although some rabbits were heavily parasitized, the effect on the host was minimal. All hares and rabbits examined possessed good body fat and appeared to be in good health. This observation suggests that parasites do not act as severe limiting factors in South Dakota lagomorphs.

This study established the existence and distribution of helminths in wild lagomorphs of South Dakota. Cestodes of the genus Cittotaenia were the predominant helminths recovered. Immature tapeworms were collected primarily in January and February of 1983. Mature worms replaced these immature forms by mid-April. Nematodes were found in only a few instances and generally in low numbers. It should be noted that no trematodes or acanthocephalans were found.

White-tailed jack rabbits and eastern cottontail rabbits were the animals sampled in largest numbers. The white-tailed jack rabbits were relatively free of parasites, while the eastern cottontail rabbits

were more heavily parasitized. The difference in parasite burdens can possibly be related to the dissimilarity of the habitats occupied by these two species. White-tailed jack rabbits generally inhabit open areas away from shelterbelts, while eastern cottontails are usually found within shelterbelts and woodlots. This relationship would allow for more efficient cycling of parasites through a population of eastern cottontails than the more free-ranging white-tailed jack rabbits.

This study represents a starting point in the understanding of parasites of South Dakota lagomorphs. Further research should be initiated on the parasites of species not covered here, and it should be continued in respect to the desert cottontail rabbits and white-tailed jack rabbits in western South Dakota. Data collected would provide a much clearer picture of the parasites present, their densities and their distribution throughout the state.

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Yorke, W., and P. A. Maplestone. 1926. The nematode parasites of vertebrates. J. A. Churchill and Co. London.

*Citations used primarily in the preparation of tables in Appendix I and identification of specimens.

PLATE I

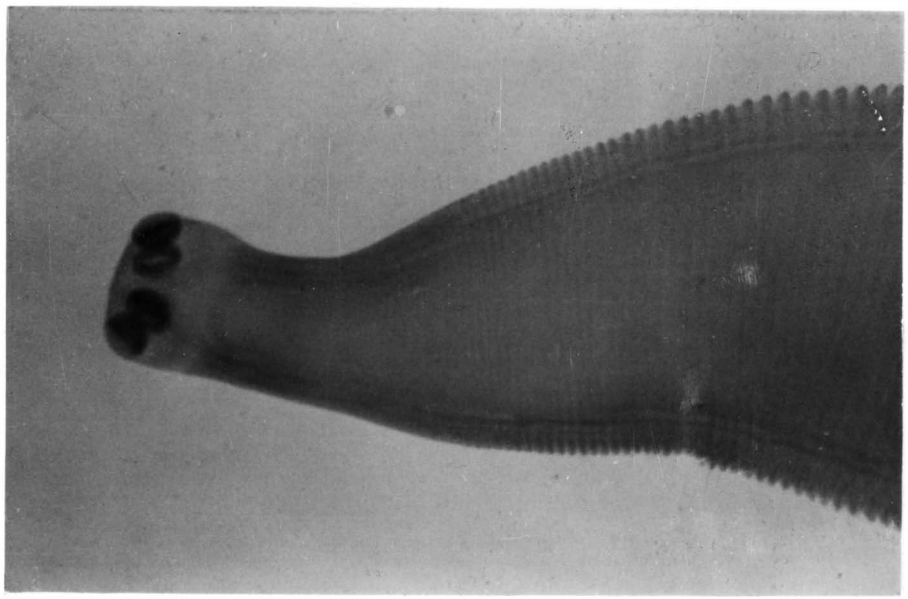

Figure 1. Immature scolex of Cittotaenia perplexa.

Figure 2. Mature scolex of Cittotaenia perplexa.

PLATE II

Figure 3. Immature strobila of Cittotaenia perplexa.

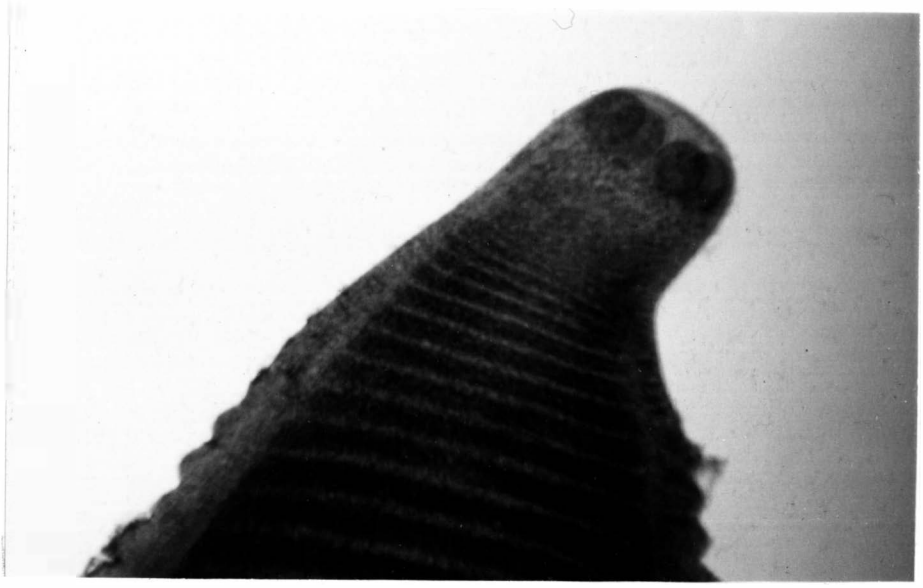

Figure 4. Immature scolex of Cittotaenia perplexa.

PLATE III

Figure 5. Gravid proglottid of Cittotaenia pectinata americana.

Figure 6. Mature scolex of Cittotaenia pectinata americana.

PLATE IV

Figure 7. Immature scolex of Cittotaenia variabilis.

Figure 8. Posterior of immature Cittotaenia variabilis showing single and double genital organs.

PLATE V

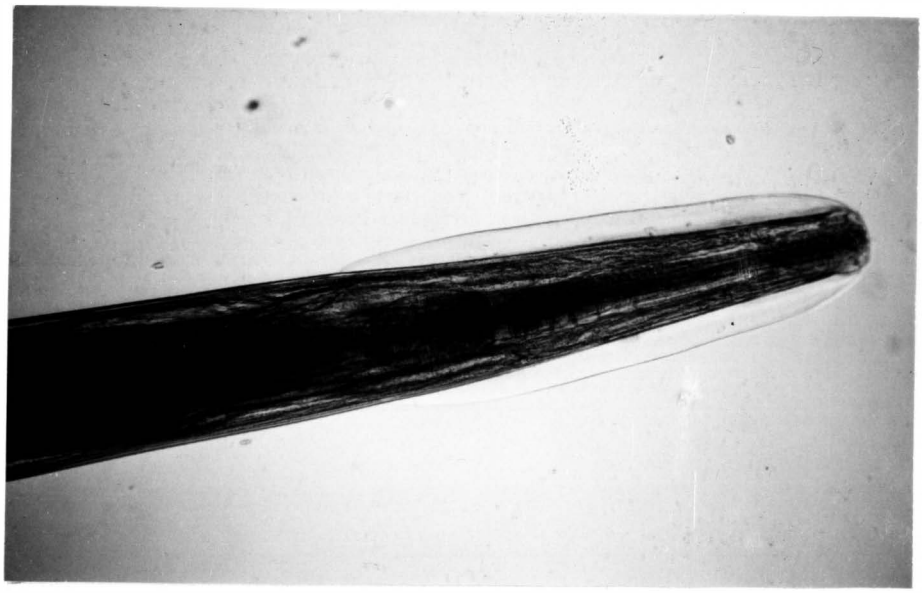

Figure 9. Anterior of female Dermatoxys veligera showing cervical alae.

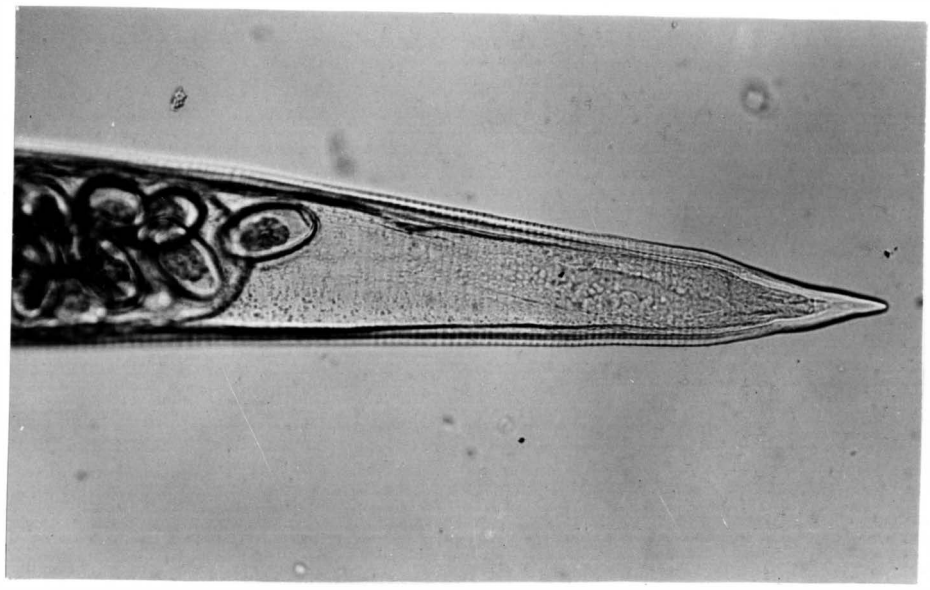

Figure 10. Posterior of female Dermatoxys veligera showing eggs in uterus.

PLATE VI

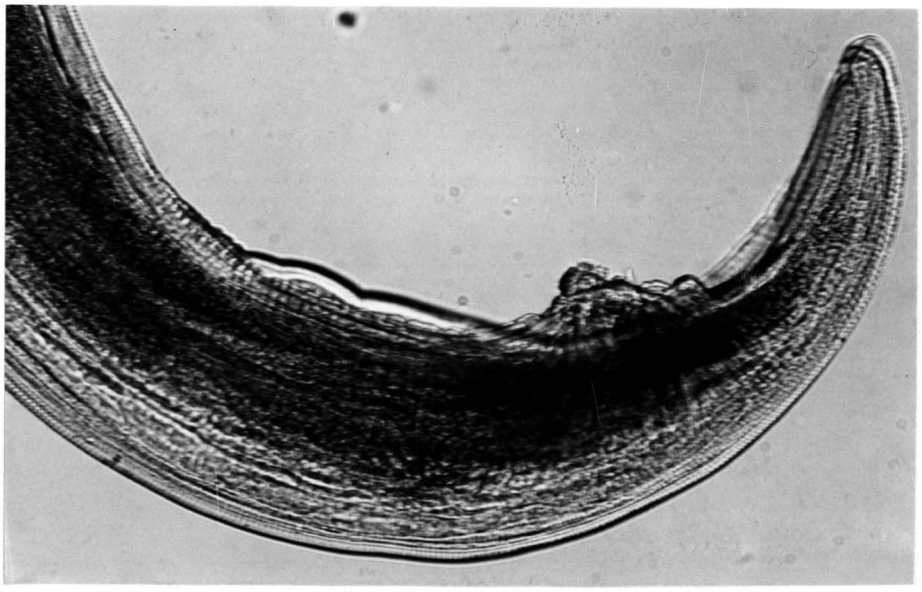

Figure 11. Posterior of male Dermatoxys veligera.

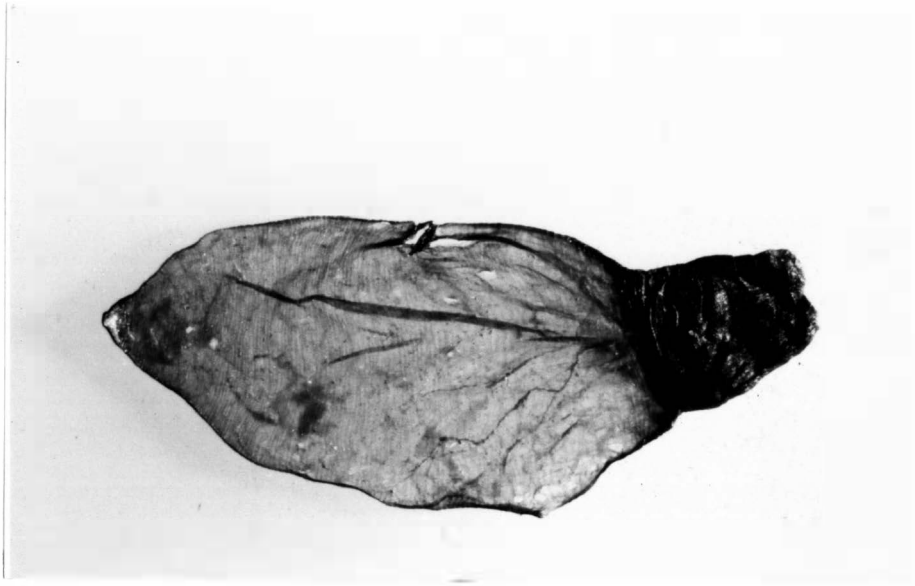

Figure 12. Cysticercus of Taenia pisiformis.

PLATE VII

Figure 13. Cediopsylla simplex female.

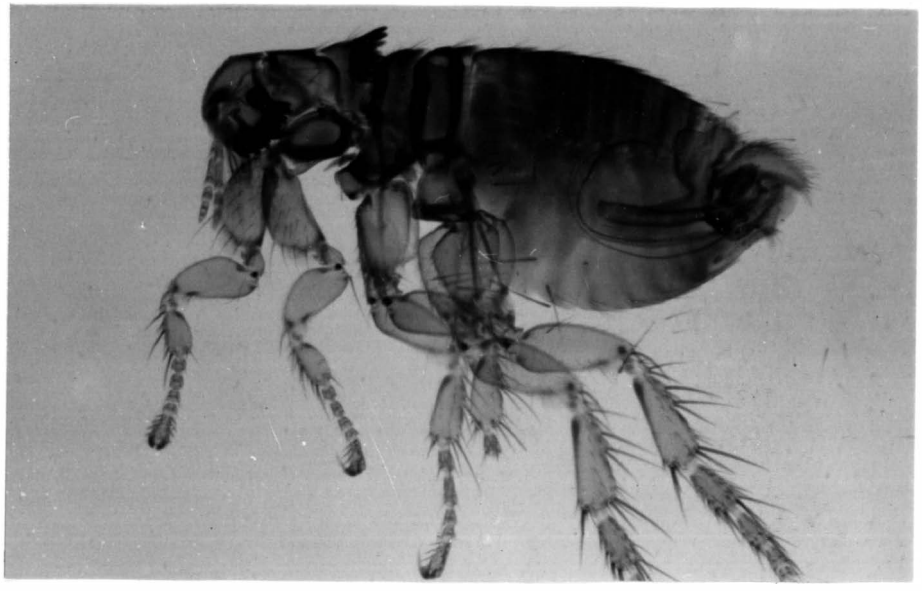

Figure 14. Cediopsylla simplex male.

PLATE VIII

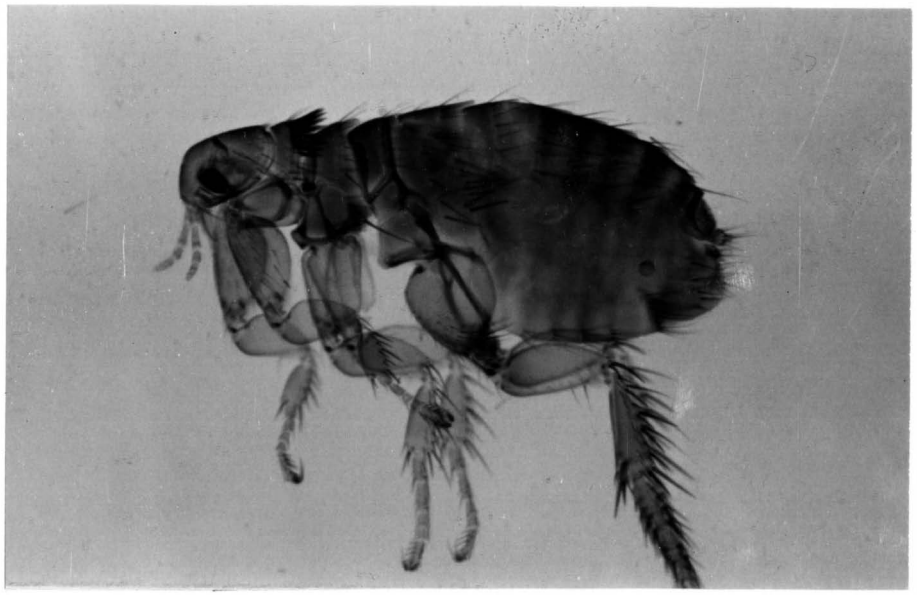

Figure 15. Euhoplopsyllus glacialis affinis female.

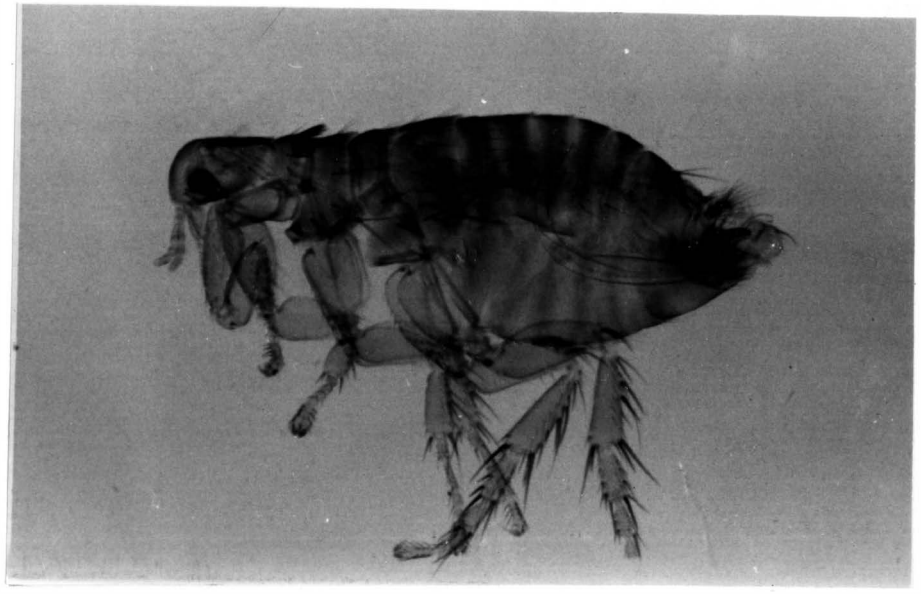

Figure 16. Euhoplopsyllus glacialis affinis male.

PLATE IX

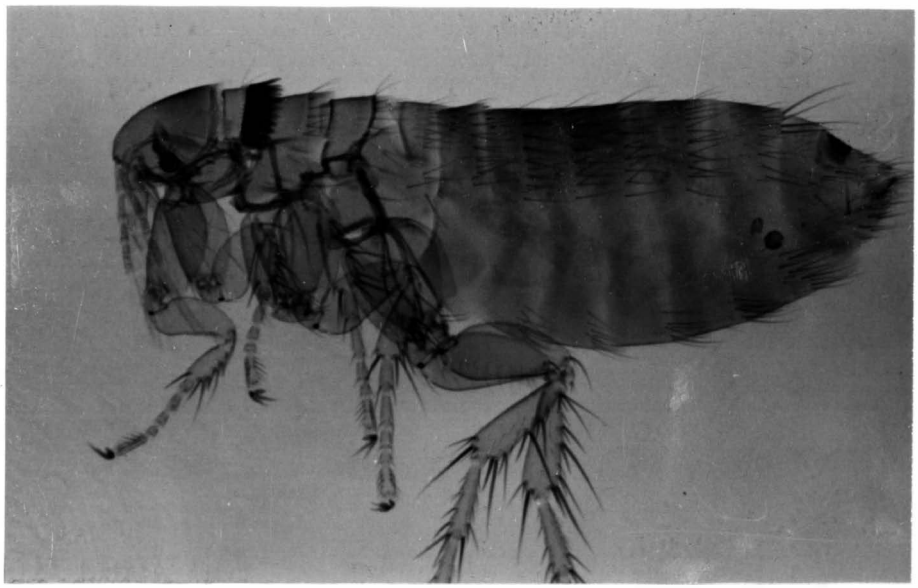

Figure 17. Opisocrostis bruneri female.

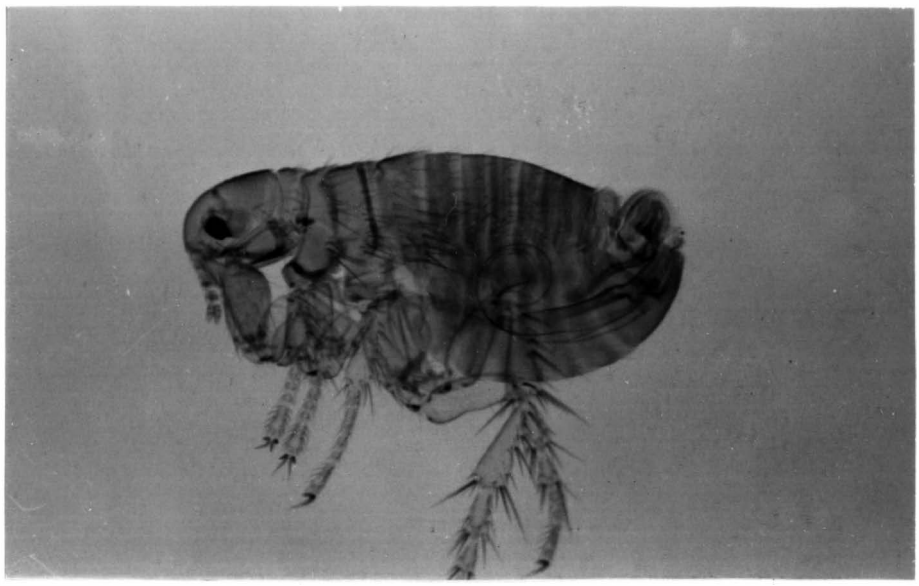

Figure 18. Pulex irritans male.

PLATE X

Figure 19. Haemaphysalis leporis palustris female.

APPENDIX I

Table A. Helminths Reported from WHite-tailed Jack Rabbits in North America

Species	Organ Infested	Prevalence Reported	Distribution
CESTODES			
Multiceps sp. (coenuri)	Skeletal muscles, thoracic cavity and right ventricle of the heart	8.2%	North Dakota
Multiceps serialis (coenuri)	Connective tissue of the musculature	10%-90%	Colorado
Taenia pisiformis (cysticerci)	Visceral mesentaries and surrounding the rectum	Up to 3.2%	North Dakota and Colorado
Cittotaenia sp.	small intestine	3.2%	North Dakota
Cittotaenia pectinata americana (=*Mosgovoyia pectinata americana*	small intestine		Wyoming
Raillietina Fuhrmannetta) *stilesiella* (=*Davainea salmoni*)	small intestine	----	Colorado

Table A (continued)

Species	Organ Infested	Prevalence Reported	Distribution
Raillietina (Paroniella) retractilis	small intestine	----	Wyoming
Raillietina (Raillietina) loeweni	small intestine	15.0%	North Dakota
NEMATODES			
Dermatoxys veligera	cecum	----	Wyoming
Protostrongylus sylvilagi	lungs	----	Wyoming
Filariid sp. (possibly *Miscipsella brevicauda*)	blood	6.9%	North Dakota

Table B. Helminths Reported from Eastern Cottontail Rabbits in North America

Species	Organ Infested	Prevalence Reported	Distribution
CESTODES			
Multiceps sp. (coenuri)	connective tissue of the musculature	-----	Minnesota
Multiceps serialis (coenuri)	connective tissue	3.2%-6.4%	Colorado, Oklahoma, Alabama and North Dakota
Taenia pisiformis (cysticerci)	visceral mesentaries liver, pleural cavity, body cavity and around the rectum	3.2%-74.1%	Kansas, Ohio, Oklahoma, Connecticut, Iowa, Michigan, Massachusetts, Minnesota, Alabama, Illinois, Mississippi, Virginia, North Carolina, North Dakota, Kentucky, Maryland, Georgia, South Carolina and Arkansas
Cittotaenia sp.	small intestine	8.4%-32.0%	Minnesota, Illinois, Kansas and Pennsylvania

Table B (continued)

Species	Organ Infested	Prevalence Reported	Distribution
Cittotaenia variabilis (=Ctenotaenia variabilis)	small intestine	28.4%-77.8%	Nebraska, Kansas, Wyoming, Connecticut, Iowa, Massachusetts, Minnesota, Alabama, Virginia, North Carolina, North Dakota, Kentucky, Maryland, South Carolina, Georgia, Mississippi and Arkansas
Cittotaenia ctenoides	small intestine	6.5%-87.1%	Oklahoma, Mississippi, North Dakota
Cittotaenia perplexa (=Mosgovoyia perplexa)	small intestine	19.0%-33.6%	Wyoming, Minnesota, Pennsylvania, New Jersey, New York, Connecticut, Rhode Island, Virginia, West Virginia, Maryland and Alabama
Cittotaenia pectinata (=Mosgovoyia pectinata americana)	small intestine	1.8%-67.0%	Wyoming, Michigan, Minnesota and North Dakota

Table B (continued)

Species	Organ Infested	Prevalence Reported	Distribution
Raillietina sp.	small intestine	----	North Carolina
Raillietina (*Fuhrmannetta*) *stilesiella* (=*R. salmoni*)	small intestine	11.0%-53.0%	Georgia, Alabama, Mississippi, Arkansas, South Carolina, North Carolina, Virginia, Maryland and Kentucky
Raillietina (*Paroniella*) *retractilis*	small intestine	24.6%	Wyoming
NEMATODES			
Trichostrongylus sp.	small intestine	1.5-24.0%	Michigan and Kansas
Trichostrongylus calcaratus	small intestine	3.1%-85.0%	Maryland, Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Arkansas, New Jersey, Iowa, Oklahoma, Connecticut, Kansas, New York, Pennsylvania, West Virginia, Minnesota and Kentucky

Table B (continued)

Species	Organ Infested	Prevalence Reported	Distribution
Trichostrongylus affinis	small intestine	5.2%-71.0%	Kansas, Maryland, Missouri, New York, Pennsylvania, Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Arkansas, New Jersey and Minnesota
Trichostrongylus retortaeformis	small intestine	----	Ohio
Trichostrongylus ransomi	small intestine	----	Louisiana
Obeliscoides cuniculi	stomach and small intestine	16.6%-93.0%	New Jersey, Ohio, Maryland, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Missouri, Arkansas, Pennsylvania, New York, Kentucky, Kansas, Illinois, Massachusetts, Minnesota, Connecticut, Oklahoma and Ontario, Canada

Table B (continued)

Species	Organ Infested	Prevalence Reported	Distribution
Graphidium strigosum	stomach and small intestine	11.5%	Oklahoma
Passalurus ambiguus	cecum and large intestine	2.1%-23.1%	Oklahoma, Connecticut, Maryland, New Jersey, Pennsylvania, Massachusetts, Minnesota, Alabama, Kansas, North Carolina, South Carolina and Georgia
Passalurus nonanulatus	cecum and large intestine	17.9%-25.0%	New York, Minnesota and Virginia
Physaloptera sp.	stomach	1.0%-1.0%	Minnesota, Missouri, and Pennsylvania
Longistriata sp.	small intestine	40.0%	Alabama
Lengistriata noviberiae	small intestine	2.9%-51.0%	North Carolina, South Carolina, Georgia, Alabama, Mississippi, Arkansas, Pennsylvania and Kentucky

Table B (continued)

Species	Organ Infested	Prevalence Reported	Distribution
Nematodirus leporis	small intestine	1.0%-15.2%	Ohio, Iowa, Pennsylvania, Maryland and Kansas
Nematodrus triangularis	small intestine	2.1%-6.5%	Minnesota and North Dakota
Nematodirus arizonensis	small intestine	1.0%	Kansas
Trichuris leporis	cecum and large intestine	6.4%-29.0%	Ohio, Iowa, Oklahoma, Maryland, Missouri, Pennsylvania, Virginia, Minnesota, Alabama, Illinois, Kansas, Georgia, South Carolina, Arkansas, Mississippi, and Kentucky
Trichuris sylvilagi	cecum and large intestine	3.2%	Maryland and North Dakota

Table B (continued)

Species	Organ Infested	Prevalence Reported	Distribution
Dermatoxys veligera	cecum and large intestine	1.5%-60%	Ohio, Kansas Maryland, Virginia, Missouri, Pennsylvania, Minnesota, Alabama, North Dakota, Georgia, South Carolina, North Carolina, Mississippi, Arkansas and Kentucky
Hepaticola hepatica	liver	1.0%	Oklahoma
Gongylonema pulchrum	----	1.0%	South Carolina and Alabama
Heterakis gallinae	cecum	1.0%	Ohio
Dirofilaria scapiceps	joints of feet	Up to 15.0%	Connecticut, Ohio, Mississippi, Georgia, South Carolina, North Carolina, Virginia and Arkansas

Table B (continued)

Species	Organ Infested	Prevalence Reported	Distribution
TREMATODES			
Hasstilesia tricolor	small intestine	1.0%-41.0%	Iowa, Michigan, Pennsylvania, New Jersey, New York, Connecticut, Rhode Island, Virginia, West Virginia, Maryland, Alabama, Minnesota, Kansas, North Carolina, South Carolina, Mississippi, Arkansas and Kentucky
Hasstilesia texensis	small intestine	----	Alabama
Nudacotyle novicia	small and large intestine	----	Alabama
Fasciola hepatica	common bile duct	20.8%	Texas

Table C. Helminths Reported from Desert Cottontail Rabbits in North America

Species	Organ Infested	Prevalence Reported	Distribution
CESTODES			
Taenia pisiformis (cysticerci)	visceral mesentaries and around the rectum	Up to 36.4%	Wyoming, California, and Colorado
Cittotaenia variabilis	small intestine	59.1%	California
Raillietina (Paroniella) retractilis	small intestine	Up to 4.5%	Wyoming and California
Raillietina (Fuh mannetta) stilesiella (=*R.(F.) salmoni*	small intestine	----	Wyoming
Raillietina (Raillietina) sp.	small intestine	75.0%	Oklahoma
Raillietina (Raillietina) loeweni	small intestine	25.0%-100%	Oklahoma and Texas
NEMATODES			
Capillaria hepatica	liver	----	Wyoming
Trichostrongylus calcaratus	small intestine	20.0%-40.0%	Texas

Table C (continued)

Species	Organ Infested	Prevalence Reported	Distribution
Passalarus ambiguus	cecum and large intestine	20.0%-31.8%	Texas and California
Passalurus nonanulatus	cecum and large intestine	----	Wyoming
Nematodirus leporis	small intestine	68.2%	California
Nematodirus neomexicanus	small intestine	----	Wyoming
Obeliscoides cuniculi	stomach and small intestine	43.2%	California
Dermatoxys veligera	cecum and large intestine	6.8%-40.0%	California, Texas and Wyoming
Trichuris leporis	cecum and large intestine	----	Wyoming